

DET KONGELIGE DEPARTEMENT
FOR HANDEL, SJØFART, INDUSTRI, HÅNDVERK OG FISKERI

NORGES SVALBARD- OG ISHAVS-UNDERSØKELSER
LEDER: ADOLF HOEL

SKRIFTER OM SVALBARD OG ISHAVET

No. 47

B. LYNGE

A REVISION OF THE GENUS
RHIZOCARPON (RAM.) TH. FR.
IN GREENLAND



OSLO
I KOMMISJON HOS JACOB DYBWAD
1932

Results of the Norwegian expeditions to Svalbard 1906—1926 published in other series. (See Nr. 1 of this series.)

The results of the Prince of Monaco's expeditions (Mission Isachsen) in 1906 and 1907 were published under the title of 'Exploration du Nord-Ouest du Spitsberg entreprise sous les auspices de S.A.S. le Prince de Monaco par la Mission Isachsen', in *Résultats des Campagnes scientifiques*, Albert Ier, Prince de Monaco, Fasc. XL—XLIV. Monaco.

ISACHSEN, GUNNAR, Première Partie. Récit de voyage. Fasc. XL. 1912. Fr. 120.00.

With map: Spitsberg (Côte Nord-Ouest). Scale 1:100 000. (2 sheets.) Charts: De la Partie Nord du Foreland à la Baie Magdalena, and Mouillages de la Côte Ouest du Spitsberg. ISACHSEN, GUNNAR et ADOLF HOEL, Deuxième Partie. Description du champ d'opération. Fasc. XLI. 1913. Fr. 80.00.

HOEL, ADOLF, Troisième Partie. Géologie. Fasc. XLII. 1914. Fr. 100.00.

SCHETELIC, JAKOB, Quatrième Partie. Les formations primitives. Fasc. XLIII. 1912. Fr. 16.00.

RESVOLL HOLMSEN, HANNA, Cinquième Partie. Observations botaniques. Fasc. XLIV. 1913. Fr. 40.00.

A considerable part of the results of the ISACHSEN expeditions in 1909 and 1910 has been published in *Videnskapsselskapets Skrifter. I. Mat.-Naturv. Klasse, Kristiania (Oslo)*.

ISACHSEN, GUNNAR, Rapport sur l'Expédition Isachsen au Spitsberg. 1912, No. 15. Kr. 5,40.

ALEXANDER, ANTON, Observations astronomiques. 1911, No. 19. Kr. 0,40.

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HOEL, A. et O. HOLTEDAHL, Les nappes de lave, les volcans et les sources thermales dans les environs de la Baie Wood au Spitsberg. 1911, No. 8. Kr. 4,00.

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BACKLUND, H., Über einige Olivinknollen aus der Lava von Wood-Bay, Spitzbergen 1911, No. 16. Kr. 0,60.

HOLTEDAHL, OLAF, Zur Kenntnis der Karbonablagerungen des westlichen Spitzbergens. I. Eine Fauna der Moskau Stufe. 1911, No. 10. Kr. 3,00. II. Allgemeine stratigraphische und tektonische Beobachtungen. 1912, No. 23. Kr. 5,00.

HOEL, ADOLF, Observations sur la vitesse d'écoulement et sur l'ablation du Glacier Lilliehöök au Spitsberg 1907—1912. 1916, No. 4. Kr. 2,20.

VEGARD, L., L'influence du sol sur la glaciation au Spitsberg. 1912, No. 3. Kr. 0,40.

ISACHSEN, GUNNAR, Travaux topographiques. 1915, No. 7. Kr. 10,00.

With map: Spitsberg (Partie Nord-Ouest). Scale 1:200 000 (2 sheets).

GUNNAR ISACHSEN has also published: Green Harbour, in *Norsk Geogr. Selsk. Aarb.*, Kristiania, 1912—13, Green Harbour, Spitzbergen, in *Scot. geogr. Mag.*, Edinburgh, 1915, and, Spitzbergen: Notes to accompany map, in *Geogr. Journ.*, London, 1915.

All the above publications have been collected into two volumes as *Expédition Isachsen au Spitsberg 1909—1910. Résultats scientifiques*. I, II. Kristiania 1916.

As the result of the expeditions of ADOLF HOEL and ARVE STAXRUD 1911—1914 the following memoir has been published in *Videnskapsselskapets Skrifter. I. Mat.-Naturv. Klasse*.

HOEL, ADOLF, Nouvelles observations sur le district volcanique du Spitsberg du Nord. 1914, No. 9. Kr. 2,50.

The following topographical maps and charts have been published separately:

Bjørnøya (Bear Island). Oslo 1925. Scale 1:25 000. Kr. 10,00.

Bjørnøya (Bear Island). Oslo 1925. Scale 1:10 000. (In six sheets.) Kr. 30,00.

Chart of Bear Island. (No. S1). Oslo 1929. Scale 1:40 000 Kr. 4,00. (With description.)

Bear Island Waters. (No. S2). Oslo 1930. Scale 1:350 000. Kr. 5,00.

Spitsbergen. Chart, Bellsund—Forlandsrevet including Isfjorden. (No. S3). Scale 1:200 000. Kr. 5,00.

A preliminary edition of topographical maps on the scale of 1:50 000 covering the regions around Kings Bay, Ice Fjord, and Bell Sound, together with the map of Bear Island, scale 1:25 000, is published in:

Svalbard Commissioner [Kristian Sindballe], Report concerning the claims to land in Svalbard. Part I A, Text; I B, Maps; II A, Text; II B, Maps. Copenhagen and Oslo 1927. Kr. 150,00.

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Preface.

During the Norwegian expedition to Novaya Zemlya in 1921 I collected a considerable material of the lichen genus *Rhizocarpon*. When the material was determined I identified no less than 26 species in it. *Rhizocarpon* was, perhaps, the genus of crustaceous lichens which gave me the greatest satisfaction.

I had hoped to find the genus equally well represented in Spitsbergen and in North East Greenland, and collected *Rhizocarpons* extensively in Bellsund, Spitsbergen, in 1926, and in North East Greenland in 1929.

My own Spitsbergen collection of *Rhizocarpon* contained only 12 species. The determinations are not yet quite definitive. But a revision of the whole genus in Spitsbergen is far advanced, and will appear as soon as possible.

My Greenland result was still poorer. In North East Greenland I only collected 8 species, less than one-third of my Novaya Zemlya harvest. That may be due either to inefficient work on my part, or to an extreme paucity of the *Rhizocarpon* flora in North East Greenland.

In order to clear up that question I determined all the *Rhizocarpons* which I could find in Th. M. Fries's collection from West Greenland in 1871. — Unfortunately, this very important collection has remained undetermined. It belongs to the Swedish "Naturhistoriska Riksmuseet", and Professor Samuelsson has entrusted it to me for determination. The work is advancing. — Th. Fries's material was considerably richer than mine. It contained in all 12 species. But even that is little enough, as compared with the rich *Rhizocarpon* flora of Novaya Zemlya.

With his usual liberality Dr. Carl Christensen, inspector of the Botanical Museum of Copenhagen, allowed me to examine the entire Greenland material of his museum. After this revision the entire number of *Rhizocarpons* from the whole of Greenland attained only 17 different species.

I am convinced that a careful exploration of the Julianehaab district by a trained lichenologist would increase the number, we do not know

how much. But the available material is so large that it must be representative. And it shows that the genus *Rhizocarpon* is very poorly represented in Greenland, especially in North East Greenland, with its arid climate and its lack of bird-cliffs.

The paucity is in respect of the number of species, not so much in the number of individuals. There were about 300 plants of the genus in my East Greenland collection. Special attention was given to the "rare" species, but yet about two-thirds of the material belonged to one species (*Rhiz. disporum*), and another species (*Rhiz. geographicum*) represented by far the greater part of the remainder.

I have not been able to include Scholander's *Rhizocarpons* from East Greenland, 1930, in this paper. The material has only in part been mounted, a work that requires much time with lichen collections. Its *Rhizocarpons* are so far inaccessible. It is probable that it will contain several interesting species. But it is not expected that it will change the general impression of the genus *Rhizocarpon* in Greenland.

The most important contributor to the *Rhizocarpons* of Greenland is Th. M. Fries. He was the first trained lichenologist to work in Greenland, and he visited some of the richest parts of the island.

Other important collectors are Jens Vahl, the founder of our knowledge of the Greenland lichen flora. He detected, in all, 6 species. Further Eberlin, who collected 7 species, and Hartz, who also collected 7 species.

Th. M. Fries's collections belong to the Swedish "Naturhistoriska Riksmuseet" in Stockholm and an almost complete set of duplicates to the Botanical Museum of Oslo. — My own collections belong to the Botanical Museum of Oslo. — All the other collections are in the possession of the Botanical Museum of Copenhagen, with the exception of the lichens which Th. M. Fries determined for the English Polar Expedition.

We are indebted to Th. M. Fries for his masterly treatment of the genus in *Lichenographia Scandinavica*, and to Malme (1914) and Vainio (1922) for equally important contributions. After that there was not much for me to do from a purely systematical point of view. — I have not had the privilege to examine critical types for this paper, and have therefore restricted the bibliographical references to the leading general papers, also to the special Greenland literature and to some other papers on Arctic lichens. Further references to former literature will be found in several of these papers, and in Zahlbruckner's *Catalogus Lichenum*.

I have been much interested in a comparison of the *Rhizocarpons* of Greenland, and the flora of the same genus in other Arctic regions, and I have tried to do it in the following enumeration.

The Svalbard enumeration is based on the material in our herbarium (Oslo), supplied with one record (*Rhiz. Rittokense*) from Th. Fries Lich. Spitsb. p. 44. This species has only been collected once there, in Hornsund by the Swedish botanist Malmgren.

The most important Svalbard material is the collection of Th. M. Fries (1868, unpublished), which I have determined, further my own collection from Bellsund (1926), and numerous other collections of different size, brought home by Norwegian botanists, for the greater part unpublished.

There are still a few undetermined plants, which may possibly increase the number. A final revision of some determinations is reserved.

The most important literary source is Th. M. Fries Lichenes Spitsbergenses, of 1867.

The Novaya Zemlya enumeration is based on Magnusson New Spec. Lich. in the North of U. S. S. R., 1927, and on my own paper Lichens from Novaya Zemlya, 1928. I have not ventured to include *Rhiz. Oederi*, mentioned by Deichmann Branth in Lich. Nov. Zeml., 1887, for some plants in the Copenhagen herb. which he referred to that species, were only *Lecidea Dicksonii*; *Rhiz. Oederi* has never been recorded from the Arctic, as far as I know.

The Bering Strait enumeration gave me greater difficulties. It is, of course, based on Nylander's Enumeratio Lichenum Freti Behringi, 1888, and on Vainio Lichenes prope Pitlekai collecti, 1909. Nylander did not always give due consideration to species proposed by other authors, and Vainio has referred some of his new species to other species formerly described, in his works of 1909 and 1922.

Malme has been kind enough to examine some of his species, which could not be utilized for my list without a revision. Malme writes that Nylander's *Lecidea alpicola* from Konyam Bay calls to mind *Rhiz. superficiale* (= *Rhiz. effiguratum*), recorded from Pitlekai by Vainio; *Rhiz. chionophiloides* or *Rhiz. subalpicolum* could also be taken into consideration. It is, perhaps, an undescribed species, anyhow not *Rhizocarpon alpicola*, as understood by Malme. — *Lecidea atroalba* is lacking in the herb. of Riksmuseum, Stockholm. — I do not know the exact meaning of Nylander's names *Lecidea eupetraeoides* and *Lecidea excentrica*.

It is possible that a few other of Nylander's names should be united with other *Rhizocarpons* mentioned in this paper, which would give them a wider range than my enumeration suggests. But it is not probable that they are identical with other species, which Nylander himself records from the Bering Strait region, an eventual rearrangement of these few species cannot noticeably reduce the large number of *Rhizocarpons* from this region.

It is evident from this enumeration that *Rhizocarpon* is an important genus in the Arctic lichen flora.

Arctic Rhizocarpons.

| | Greenland | Svalbard | Novaya Zemlya | Bering Strait |
|--|-----------|----------|---------------|----------------|
| <i>I. Circumpolar species.</i> | | | | |
| 1. Rhiz. Copelandii (Kbr.) Th. Fr. | + | + | + | + |
| 2. — disporum (Naeg.) Müll. Arg. | + | + | + | + |
| 3. — geographicum (L.) DC. | + | + | + | + |
| 4. — grande (Flk.) Arn. | + | + | + | + |
| 5. — Hochstetteri (Kbr.) Vain. | + | + | + | + |
| 6. — polycarpum (Hepp) Th. Fr. | + | + | + | + |
| <i>II. Western Arctic species.</i> (Greenland). | | | | |
| 7 (1). Rhiz. crystalligenum Lyng. | + | — | — | — |
| 8 (2). — groenlandicum Lyng. | + | — | — | — |
| 9 (3). — occidentale Lyng. | + | — | — | — |
| 10 (4). — viridiatrum (Flk.) Kbr. | + | — | — | — |
| <i>III. Arcto-Atlantic species.</i> (Greenland—Svalbard—Novaya Zemlya). | | | | |
| 11 (1). Rhiz. badioatrum (Flk.) Th. Fr. | + | + | + | — |
| 12 (2). — chionophilum Th. Fr. | + | + | + | — |
| 13 (3). — distinctum Th. Fr. | + | — | + | — |
| 14 (4). — jemtlandicum Malme | + | + | + | — ¹ |
| 15 (5). — obscuratum (Ach.) Mass. | + | + | + | — |
| 16 (6). — Rittokense (Hellb.) Th. Fr. | + | + | + | — |
| 17 (7). — pseudospireum (Th. Fr.) Lyng. | — | + | + | — |
| <i>IV. Novaya Zemlya species.</i> | | | | |
| 18 (1). Rhiz. albidum Lyng. | — | — | + | — |
| 19 (2). — alpicola (Hepp) | — | — | + | — |
| 20 (3). — Anseris Lyng. | — | — | + | — |
| 21 (4). — atroflavescens Lyng. | — | — | + | — |
| 22 (5). — cinereoflavescens Lyng. | — | — | + | — |
| 23 (6). — cinereonigrum Vain. | — | — | + | — |
| 24 (7). — petraeum (Wulf.) Mass. | — | — | + | — |
| 25 (8). — verrucosum Lyng. | — | — | + | — |
| <i>V. Eastern Arctic species.</i> (Svalbard—Novaya Zemlya—Bering Strait). | | | | |
| 26 (1). Rhiz. chioneum (Norm.) Th. Fr. | — | + | + | + |
| 27 (2). — expallescens Th. Fr. | — | + | + | + |
| <i>VI. Siberian Arctic species.</i> (Novaya Zemlya—Bering Strait). | | | | |
| 28 (1). Rhiz. chionophiloides (Vain.) Lettau. | — | — | + | + ² |
| 29 (2). — lavatum (Fr.) Arn. | — | — | + | + |
| 30 (3). — phalerosporum Vain. | — | — | + | + |
| 31 (4). — roridulum Th. Fr. | — | — | + | + |

¹ "*Lecidea jemtlandica* (Fr. fil.)" in Nyl. Enum. Lich. Freti Behr. p. 242 is *Catillaria jemtlandica* Th. Fr.

² Malme has told me that he has seen this species in a collection from Taimir.

| | Greenland | Svalbard | Novaya Zemlya | Bering Strait |
|---|-----------|----------|---------------|---------------|
| VII. <i>Arcto-Pacific species.</i> | | | | |
| 32 (1). Rhiz. albopunctatum (Vain.) A. Zahlbr. | — | — | — | + |
| 33 (2). — "atroalbum Flot." (?) | — | — | — | + |
| 34 (3). — atroalbens (Nyl.) A. Zahlbr. | — | — | — | + |
| 35 (4). — atrocaesium (Nyl.) ¹ | — | — | — | + |
| 36 (5). — decinerascens (Nyl.) A. Zahlbr. | — | — | — | + |
| 37 (6). — detinens (Nyl.) A. Zahlbr. | — | — | — | + |
| 38 (7). — "eupetraeoides (Nyl.)" (?) | — | — | — | + |
| 39 (8). — "excentricum (Ach.)" (?) | — | — | — | + |
| 40 (9). — infernum (Nyl.) | — | — | — | + |
| 41 (10). — leucopsephum (Nyl.) A. Zahlbr. | — | — | — | + |
| 42 (11). — melaneimum (Vain.) A. Zahlbr. | — | — | — | + |
| 43 (12). — ochrodelum (Nyl.) A. Zahlbr. | — | — | — | + |
| 44 (13). — postumum (Nyl.) Th. Fr. | — | — | — | + |
| 45 (14). — praebadium (Nyl.) A. Zahlbr. | — | — | — | + |
| 46 (15). — semotulum (Nyl.) A. Zahlbr. | — | — | — | + |
| 47 (16). — subalpicolum (Nyl.) A. Zahlbr. | — | — | — | + |
| VIII. <i>American Arctic species.</i> (Bering Strait—Greenland). | | | | |
| 48 (1). Rhiz. superficiale (Schaer.) Malme ² | + | — | — | + |
| Total | 17 | 14 | 27 | 29 |

We find that the genus is much better represented in the eastern Arctic than it is in the western. The number of species from Novaya Zemlya and from the Bering Strait region is not far from twice as large as it is in Greenland and in Svalbard.

This is certainly not due to insufficient investigation in the latter two areas. The result from the Bering Strait region was obtained by a single expedition, the Vega Expedition, in 1878—79. And only one species has been added to the results of another single expedition, the Norwegian Scientific Expedition to Novaya Zemlya, in 1921.

The first lichens were brought home from Spitsbergen by Keilhau and by Jens Vahl, more than a hundred years ago, and since then the islands have repeatedly been visited by trained lichenologists, as well as by other interested botanists, who have collected lichens. The east coast of Svalbard is difficult of access, and our knowledge of its lichen flora is still quite inadequate. But the lichen flora of Bear Island, Western Spitsbergen, and the north coast of Spitsbergen and the North East Land (to North Cape), is now well known. The greatest and most

¹ Referred to *Rhizocarpum grande* f. *atrocaesium* by Zahlbruckner in Cat. Lich. IV p. 372.

² Malme has been kind enough to test his Greenland plants with J; he found a positive reaction.

important collections have so far only in part been determined, but the material is accessible to me.

We have also received lichens from Greenland during the last hundred years, and the island has repeatedly been visited by lichenologists, who have collected many lichens. As yet no lichenologist has explored the south-western district (Julianehaab), which is certainly the richest in Greenland. The number of crustaceous lichens from Greenland, the largest island in the world, can certainly be much increased, but nevertheless the available material is so large that it must be fully representative.

There are very large undetermined lichen collections from the Siberian coast, belonging to the Swedish Riksmuseum in Stockholm and the Botanical Museum in Helsingfors. When determined this material will add substantially to our knowledge.

Simmons collected many interesting *Rhizocarpons* in the Canadian Arctic islands west of Greenland, but the material is hardly large enough to be fully representative. Apart from his collections our knowledge of the Arctic American lichens is hardly worthy of mention.

I have tried to arrange the species in geographical sections, after our present knowledge. It is evident that this arrangement is provisional. It is quite probable that we can find *Rhizocarpon pseudospeireum* in Greenland, or in Eastern Siberia, or some of the (present) Siberian Arctic species farther west.

But, as it is, we are much surprised at the small number of circumpolar lichens of this genus, only 6 circumpolar *Rhizocarpons*! The number can be increased. But I will unhesitatingly venture the assertion that this low figure is a well established fact, and not due to insufficient exploration. — It is an interesting contrast to the results obtained by Scholander and myself by a study of the distribution of some other Arctic lichens, chiefly the larger fruticulose and foliaceous lichens.

We find that Greenland, as well as Novaya Zemlya and the Bering Strait region, has a certain number of species not found in the other regions, 4, 8 and 17 respectively. It is probable that this regional difference will be reduced by future research. But it is much too great to be explained by insufficient exploration alone. — I regard a great regional difference in the Arctic *Rhizocarpon* flora to be a well established fact.

It is possible that the genus has recently developed a great number of new species in either of these regions, and that the new species have not (yet) been able to migrate to any extent. — But it is of little use to discuss these problems, as long as their eventual distribution in extra-Arctic countries is so little known. We cannot understand the presence, or absence, of any species in any part of the world, if we do not study its distribution in other regions, its dependance on climatic factors,

substratum, geological time, and so forth. All the four Siberian Arctic species are found in Fenno-Scandia, and the same is the case with *Rhizocarpon postumum* and *Rhiz. superficiale*, which are Pacific or American species in the Arctic, as far as our present knowledge goes.

The general conclusion is, accordingly, that if we are to understand the distribution of Arctic lichens it is quite necessary to study the lichen flora of the adjacent high mountains, such as Altai, Ural and Rocky Mountains. In Europe the work has been done. More general results on the distribution of these lichens can be obtained from expeditions to these mountains than from expeditions to Arctic regions, apart from the unexplored American Arctic coast.

I have so far only been able to identify 14 *Rhizocarpons* from Svalbard. We do not know the cause of this paucity. Other genera are quite as well represented there as elsewhere in the Arctic. The isolation from the nearest continent, and the high northerly position explain a great deal.

Each of the Svalbard *Rhizocarpons* is found in Spitsbergen, and 10 of them in Bear Island. The Svalbard region has no species of *Rhizocarpon* that is not also found in Norway. Eleven of the fourteen are found in Greenland. All the fourteen are also found in Novaya Zemlya. Svalbard has no peculiar *Rhizocarpon* flora.

I have above contrasted the Arctic distribution of this genus with the Arctic distribution of the fruticulose and foliaceous lichens. There is a considerable difference, for the latter lichens have a much wider distribution. — That should warn us against ideas of an "Arctic flora", or the "flora of Greenland" or of other large regions, as a biological unit. Each species has its own distribution, which must be studied separately. The Arctic flora, or the flora of Greenland is only a statistical idea, like other notions of the same kind, such as the "population" of a certain country. It is no more a biological unit than the population of the United States of North America is.

Clavis specierum.

1. Sporae demum murales vel tetrablastae.

Sect. I. *Eurhizocarpon* Stiz., p. 11.

2. Thallus lutescens, raro partim subalbidus.

3. Sporae minores: (16—) 18—25×9—11 μ , diu 3-septatae; hyphae medullares J÷.

2. *Rhiz. viridiatum* (Flk.) Kbr., p. 12.

- 3*. Sporae majores: 22—36×11—18 μ , murales, cellulis numerosis; hyphae medullares J caerulescentes.

1. *Rhiz. geographicum* (L.) DC., p. 11.

- 2*. Thallus cinereus vel fuscescens.

3. Sporae maturae obscuratae.
 4. Sporae octonae (rarius quaternae); medulla J caerulescens, KOH \div , KOH + CaCl₂O₂ (vulgo CaCl₂O₂) rubescens.
 3. *Rhiz. grande* (Flk.) Arn., p. 13.
 - 4*. Sporae binae vel singulae, medulla J \div , KOH \div , CaCl₂O₂ \div .
 4. *Rhiz. disporum* (Naeg.) Müll. Arg., p. 15.
- 3*. Sporae persistenter decoloratae.
 4. Hymenium KOH superne roseo-violascens, sporae diu vel persistenter tri-septatae; hyphae medullares J caerulescentes.
 5. *Rhiz. distinctum* Th. Fr., p. 16.
 - 4*. Hymenium KOH non reagens, sporae deinde murales, sed pauciloculatae; hyphae medullares J \div .
 6. *Rhiz. obscuratum* (Ach.) Mass., p. 17.
- 1*. Sporae persistenter dyblastae.
 - Sect. II. *Catocarpus* Th. Fr., p. 18.
 2. Thallus lutescens, raro partim albidus.
 3. Medulla KOH rubescens, crystalli fasciculata praecipituntur.
 4. Sporae majores: 18—28 \times 9—15 μ .
 7. *Rhiz. chionophilum* Th. Fr., p. 18.
 - 4*. Sporae minores: 13—16 \times 7.5—8.5 μ .
 8. *Rhiz. crystalligenum* Lynge, p. 19.
 - 3*. Medulla KOH non rubescens, sporae parvae: 13—18 \times 7—9 μ .
 4. Medulla J caerulescens.
 10. *Rhiz. superficiale* (Schaer.) Malme, p. 20.
 - 4*. Medulla J non caerulescens.
 9. *Rhiz. occidentale* Lynge, p. 20.
 - 2*. Thallus cinereus vel fuscescens.
 3. Sporae maturae obscuratae.
 4. Medulla KOH rubescens, crystalli fasciculata praecipituntur.
 11. *Rhiz. Copelandii* (Kbr.) Th. Fr., p. 21.
 - 4*. Medulla KOH non rubescens.
 5. Hymenium KOH superne roseoviolascens.
 6. Thallus areolatus vel verrucosus, sporae majores: 30—35 \times 13—16 μ .
 12. *Rhiz. badioatrum* (Flk.) Th. Fr., p. 22.
 - 6*. Thallus peltato-squamosus, sporae minores: 22—28 \times 12—14 μ .
 13. *Rhiz. Rittokense* (Hellb.) Th. Fr., p. 22.
 - 5*. Hymenium KOH smaragdulum vel fuligineo-nigricans.

6. Thallus CaCl_2O_2 rubescens, sporae minores: $17-21 \times 10-11 \mu$.
 14. *Rhiz. groenlandicum* Lynge, p. 23.
 6*. Thallus CaCl_2O_2 non rubescens, sporae majores: $25-30 \times 13-15 \mu$.
 15. *Rhiz. jemtlandicum* Malme, p. 24.
 3*. Sporae persistenter decoloratae.
 4. Hyphae medullares J caerulescentes, hymenium superne violaceo-nigricans, paraphyses apice haud incrassatae.
 16. *Rhiz. polycarpum* (Hepp) Th. Fr., p. 25.
 4*. Hyphae medullares J ÷, hymenium superne smaragdulo-nigricans, paraphyses apice capitatae.
 17. *Rhiz. Hochstetteri* (Kbr.) Vain., p. 25.

Sect. I. *Eurhizocarpon* Stiz.

1. *Rhizocarpon geographicum* (L.) DC.

Th. Fries Lich. Arct. (1860) p. 236, Lich. Spitsb. (1867) p. 46, Lich. Scand. II (1874) p. 622, Lich. Engl. Polar Exp. (1879) p. 365. Malme *Rhizocarpon* (1914) p. 276 et 282. Deichmann Branth et Grönlund Grönl. Lich. Flora (1887) p. 507. Darbishire Lich. Fram Exp. (1909) p. 23. Galløe Lich. North-East Greenl. (1910) p. 191. Vainio Lich. Fenn. II (1922) p. 277 et 280. Merrill Lich. Canad. Arct. Exp. (1924) p. 6 D. Lynge Lich. North Coast of Greenland (1923) p. 287, Lich. Spitsb. I (1924) p. 19, Lich. Bear Isl. (1926) p. 36, Lich. Nov. Zemlya (1928) p. 139 et pl. III, fig. 11—12, Lich. Taimir Peninsula (1929) p. 12, Lich. Franz Josef Land (1931) p. 12, Lich. South-East Greenl. (1932) p. 14. Zahlbr. Cat. Lich. IV (1927) p. 359. *Lecidea geographica* (L.) Fr. Nylander Enum. Lich. Freti Behringii (1888) p. 234 et 254. Vainio Lich. Exped. Amdrup (1905) p. 137, Lich. Pitlek. (1909) p. 110.

North Greenland. J. P. Koch Fjord and Centrum Isl. (Wulff). Egerton Valley, Westward-Ho Valley, and other localities in the vicinity of "Alert's" winter-quarters; Cape Sabine; Alexandra Haven (Th. Fr. (1879) l. c.).

West Greenland. Umanaq (Eberlin). Disko: Atanikerdluk, Nordfjorden, Mellemfjorden, Blaafjell (= Uivfaq), Nepisat and Laksebugten (Th. Fr.); Marraq (Kold. Ros.); Ekalunguit Itivnerit (Porsild). Holsteinsborg (Vahl). Godthaab (Th. Fr.). Fredrikshaab: Fiskenæsset (= Qeqertarsuatsiaq (Grönlund) and Bjørnesund at Manut (Kornerup). Julianehaab: Nanortalik (Vahl, Eberlin) and Amitsuarsuk (? I have read Annutsuarsuk on the label; leg. Vahl).

East Greenland. Nuk (Eberlin). Kvaleritsedlerkoda (Eberlin; not identified locality). Scoresbysund: Danmarks Ø and Taakefjorden

(Hartz); Fleming Inlet (Vain. 1905, l. c.). Davysund and Kong Oscar Fjord: Cape Simpson and Holmsvika (Lyngé). Vegasund: Scott Keltie Isl.: Gåsöya, and Veganeset (Lyngé). Sofiasund: Celsiusberget (Lyngé). Franz Josef Fjord: Dusén Fjord, Cape Humboldt, Cape Bennet, Muskox Fjord, Vargbukta, Reinbukta and Kierulf Fjord (Lyngé). Near Cape Wynn: Landingsdalen (Lyngé). Danmarks Havn (Galløe l. c.).

Not identified localities: Grönland (Rink).

Rhizocarpon geographicum is a circumpolar lichen, and all records call it plentiful everywhere. — It is also found all over the coasts of Greenland, and evidently equally plentiful everywhere.

One plant from Veganeset has an almost white thallus: f. *subcinerascens* (Nyl.) Deichm. Branth.

"*Rhizocarpon alpicola*" has repeatedly been recorded from Greenland. The greater part of the material belongs to *Rhizocarpon chionophilum* Th. Fr., as understood also by Malme and Vainio.

One *Rhizocarpon* from North Greenland: Centrum Island, leg. Wulff, was referred to *Rhiz. alpicola* by the present author (Lichens from the North-Coast of Greenland, Medd. om Grönl. LXIV (1923) p. 287. The plant has small spores: $11-17 \times 7.5-10 \mu$, they are very impellucid, almost black, with one distinct transversal septum. The reaction is $\text{KOH} \div$. These observations suggested the above determination. But on re-examination of the plant for the present paper I found a blue medullary reaction with J, and when the section of an apothecium was heated with lactic acid, I detected a few other very indistinct septa. *Rhizocarpon alpicola* is, accordingly, out of the question, and also *Rhiz. superficiale* (= *Rhiz. effiguratum*), on account of its spores and its habitus. The plant must be referred to *Rhiz. geographicum*, in spite of its very small spores.

Rhizocarpon alpicola (Schaer.) Flag. (= *Rhiz. oreites* (Vain.) Zopf) has so far not been found in Greenland.

2. *Rhizocarpon viridiatum* (Flk.) Kbr.

Th. M. Fries Lich. Scand. II (1874) p. 623. Malme *Rhizocarpon* (1914) p. 276. Vainio Lich. Fenn. II (1922) p. 277 et 283. Zahlbr. Cat. Lich. IV (1927) p. 394.

Julianehaab: Nanortalik (Eberlin).

This is a very interesting find. It has formerly never been recorded from Greenland, and, as far as I can see, it is an addition to the Arctic lichen flora (cfr. Lyngé Lich. Franz Josef Land (1931) p. 30).

There is no visible hypothallus. The apothecia are scattered, surrounded by a few small areolae. The spores are $16-20 \times 8.5-10 \mu$, very rarely up to $30 \times 12 \mu$. They remain 3-septated for a long time,

but a few spores with a longitudinal septum were also found. The spores are so dark that the septa can only be seen after clearing, except in young spores. The hymenium is high: 100—125 μ , violet or blackish-violet. — Its habitus is that of a very poorly developed *Rhiz. geographicum*, but it is well distinguished from that species by its small 3-septated spores, and especially by its negative medullary reaction with J.

3. *Rhizocarpon grande* (Flk.) Arn.

Th. M. Fries Lich. Scand. II (1874) p. 624 p. p., Lich. Engl. Polar Exp. (1879) p. 365. Deichm. Branth et Grönlund Grönl. Lich.-Flora (1888) p. 507. Malme *Rhizocarpon* (1914) p. 278 et 288. Vain. Lich. Fenn. II (1922) p. 277 et 286. Lynge Lich. Spitsb. I (1924) p. 19, Lich. Bear Isl. (1926) p. 36, Lich. Nov. Zeml. (1928) p. 142, Lich. Taimir Penins. (1929) p. 12, Lich. Franz Josef Land (1931) p. 13. Zahlbr. Cat. Lich. IV (1927) p. 371. *Rhizocarpon petraeum* (Wulf.) Th. Fr. Lich. Arct. (1860) p. 235, Lich. Spitzb. (1867) p. 46. Deichm. Branth et Grönlund Grönlands Lich.-Flora (1888) p. 507, p. p. *Rhizocarpon endamy-leum* Th. Fr. Lich. Scand. II (1874) p. 627, Lich. Engl. Polar Exp. (1879) p. 365. Deichm. Branth et Grönlund Grönl. Lich.-Flora (1888) p. 507. *Lecidea grandis* (Flk.) Vain. Lich. Pitlek. (1909) p. 111.

Exsic. Fries Lich. Suec. XIV (1833) No. 406 B, Malme Lich. Suec. VII (1910) No. 172, Somrft. Plant. Crypt. Norv. II (1836) No. 128.

North Greenland. Cape Sabine (Th. Fr. l. c.).

West Greenland. Upernivik J+ (Kold. Ros.). Disko, J+, (Porsild). Holsteinsborg, J÷ (Vahl). Godthaab (Th. Fr.). Julianehaab, J÷, (Vahl), J+ (Eberlin): Nanortalik, J dilutissime caerulescens (Eberlin).

East Greenland. Scoresbysund, J÷ (Hartz): Cape Stewart, J+ (Hartz). Vegasund: Scott Keltie Isl.: Gåsöya (Lynge). Kong Oscar Fjord: Cape Humboldt and Kierulf Fjord (Lynge).

Rhizocarpon grande is a circumpolar species. It is generally found in Arctic collections, which contain some crustaceous lichens. This suggests it to be a rather common species. But it is not supposed to be plentiful anywhere, like *Rhiz. disporum* and *Rhiz. geographicum*.

It will be seen from the above enumeration that it is found all over the coasts of Greenland. The number of finds is quite considerable. But in Th. Fries's collection I detected only one plant. I was much interested in finding *Rhiz. grande* and *Rhiz. eupetraeum* in East Greenland in 1929. Not being able to distinguish habitually between these species and *Rhiz. disporum* I was obliged to collect this section very extensively, and to examine each plant microscopically. There were more than 200 plants of the latter species in my collection, only four of *Rhiz. grande*, and none of *Rhiz. eupetraeum*. So far, I have not seen *Rhiz. eupetraeum* in Greenland collections.

My East Greenland plants of *Rhiz. grande* are habitually very uniform. They are quite small, a few convex, more or less discrete areolae on a distinct, black hypothallus. The colour is grey, more or less dark. I never saw the brown colour of the plants in Malme's Lich. Suec. No. 172. My plants should perhaps be referred to f. *atrocaesia* (Nyl.) Vain. (not seen).

The hymenium is high. In one apothecium I measured up to 160μ ; in Malme's No. 172 about 110μ . The upper part of the hymenium is violet to black. The spore number in each ascus is very often lower than 8. I never saw that in my Novaya Zemlya material. Its biology is also more variable in Greenland than elsewhere. Is it, perhaps, going to be split up into several new species in the western Arctic? I have formerly suggested the same thought for *Gyrophora decussata* (Lyng. et Scholander Lich. from North East Greenland, p. 54).

The spores are dark, with 1 (—2) longitudinal septum, and 3—5 or up to 7 transversal septa, size $29-45 \times 14-19\mu$, in the "normal" plants.

The chemical reaction deserves attention. The medulla is never red with KOH, but always red with CaCl_2O_2 , at least with $\text{KOH} + \text{CaCl}_2\text{O}_2$, but in some plants this reaction is not very distinct. The normal medullary reaction with J is blue, but the reaction is often faint. In some plants it is so faint that it is only distinctly seen in the moment of decoloration with KOH ("J÷" in the above enumeration). Th. Fries had overlooked its positive J reaction when he described his *Rhiz. endamyleum*.

Its variation in Greenland can be thus expressed. I should perhaps not have attributed so much importance to it if I had found the same variation also in other Arctic regions:

f. *parasitica* Lyng. n. f.

Differt a typo sporis minoribus: $24-27 \times 10-13\mu$, sporae rarisime majores, usque ad $35 \times 13\mu$, sporae pauciloculatae, septa transversalia vulgo 3. Semper parasitica in *Rinodina Hueana*.

East Greenland. Kong Oscar Fjord: Muskox Fjord, Reinbukta and Vargbukta (Lyng.).

Its distribution is, of course, restricted to that of its host. But in this region it is certainly much more common than the self-dependent type of the species.

The plants agree well with *Rhiz. grande* with respect to the chemical reactions. The small spores are very constant of size, I only found one large spore.

var. *quaternaria* Th. Fr.

Lich. Engl. Polar Exp. (1879) p. 365.

North Greenland. Alexandra Haven (Th. Fr. l. c.).

East Greenland. Scoresbysund: Danmarks Ø (Hartz).

"Nova varietas sporis normaliter quaternis. Accords externally completely with *Rhiz. grande*; the verrucae scattered on a black hypothallus, KOH÷, J÷. The inner parts of the apothecia are as follows: — Hypothecium obscure fuscum; paraphyses graciles, gelatinam copiosam percurrentes; sporae normaliter 4nae, interdum 3nae vel 5nae, ellipsoideae, oblongae vel elongato-oblongae, rectae vel curvulae, utrinque obtusae, obscurae, halone hyalino lato circumdatae, 32—48×12—18μ; gelatina hymen. iodo intense caerulescens" (Th. Fr. l. c.).

Deichmann Branth had named Hartz's plant *Rhiz. distinctum*. But it differs habitually from that species, and it has large, dark, muriform spores, with 2—3 longitudinal septa.

Hartz's plant differs from Th. Fries's description in the medullary reaction: "medulla J pulchre caerulea", and also in the number of spores, which is "2: nae vel 3: nae". But it is hardly necessary to attribute special names to this difference.

4. *Rhizocarpon disporum* (Naeg.) Müll. Arg.

Zahlbr. Cat. Lich. IV (1927) p. 353, ubi syn. Lynge Lich. Nov. Zemlya (1928) p. 142, Lich. Franz Josef Land (1931) p. 12. *Rhizocarpon geminatum* (Flot.) Kbr. Th. M. Fries Lich. Arct. (1860) p. 234, Lich. Spitsb. (1867) p. 45, Lich. Engl. Polar Exped. (1879) p. 365, Lich. Scand. II (1874) p. 623. Deichmann Branth et Grönlund Grönl. Lich. Flora (1887) p. 507. Darbshire Lich. Fram Exped. (1909) p. 23. Gallöe Lich. North-East Greenl. (1910) p. 191. Malme *Rhizocarpon* (1914) p. 278 et 288. Lynge Lich. North Coast Greenl. (1923) p. 287, Lich. Spitsb. I (1924) p. 19, Lich. Bear Isl. (1926) p. 36. Merrill Lich. Canad. Arct. Exp. (1924) p. 6 D. *Rhizocarpon inops* Kbr. Flecht. Zw. Deut. Polar Exp. (1874) p. 81. *Lecidea geminata* Flot. Nylander Entom. Lich. Freti Behr. (1888) p. 246. *Lecidea concreta* (Ach.) Vain. Lich. Exp. Amdrup (1905) p. 137. *Rhizocarpon concretum* (Ach.) Elenk. Vain. Lich. Fenn. II (1922) p. 277 et 290.

Exsic. Havås Lich. Norv. (1901) No. 9. Malme Lich. Suec. VI (1909) No. 150, XXXIV (1923) No. 849. Vide Vain. l. c. et Lynge Index Exsic. II p. 269 et 270.

North Greenland. Centrum Isl., J. P. Koch Fjord and Low Point (Wulff). Westward-Ho, Egerton Valley, Floeberg Beach, summit of Cape Union, Polaris Bay and Cape York (sec. Th. Fries l. c. p. 365, plants not seen).

West Greenland. Disko: Atanikerdluk, Mellemfjorden and Disko (Th. Fr.), Kutdlisat (Porsild). Holsteinsborg (Vahl). Godthaab: Ameralik (Vahl). Julianehaab (Vahl): Nanortalik (Vahl).

East Greenland. Scoresbysund: Hekla Havn, Red Island, Taakefjorden (Hartz), Fleming Inlet, Turner Sound, 2000 ped. et Cape Dalton (Vain. 1905, l. c.). Kong Oscar Fjord: Holmsvika (Lyngé). Vegasund: Gåsöya, Husbukta and Veganeset (Lyngé). Sofiasund: Mt. Celsius (Lyngé). Frans Josef Fjord: Mygbukta, Cape Bennet, Muskox Fjord, Dusen Fjord, Cape Humboldt, Vargbukta, Reindalen and Kierulf Fjord (Lyngé). Jackson Island (Lyngé). Near Cape Wynn: Landingsdalen (Lyngé). Danmarks Havn (Galløe l. c.): Termometerfjell and Renskæret (Galløe l. c.).

Rhizocarpon disporum is a circumpolar lichen. It was not mentioned by Vainio in his Pitlekai work, and only once in Nylander's Enum. Lich. Freti Behringi. It is, perhaps, not so common in the Eastern Arctic (?), at least we have few plants from these regions. But between Novaya Zemlya in the east and Ellesmereland in the west it is one of the commonest of all lichens, plentiful and inevitable everywhere. There were more than 200 plants of this species in my collection from North East Greenland. The *Rhizocarpons* were eagerly collected, but the result in number of species was very poor. More than two-thirds of the whole *Rhizocarpon* material was this species, and *Rhiz. geographicum* was by far the greater part of the rest.

All the plants were microscopically examined. I have now seen so many plants where mono- and di-sporous asci were seen together in the same section that I will not even mention the "*Montagnei*" as a forma.

5. *Rhizocarpon distinctum* Th. Fr.

Th. M. Fries Lich. Scand. II (1874) p. 625. Malme *Rhizocarpon* (1914) p. 279 et 290. Vain. Lich. Fenn. II (1922) p. 278 et 310, ubi syn. Lyngé Lich. Nov. Zemlya (1928) p. 146. *Rhizocarpon ambiguum* A. Zahlbr. Cat. Lich. IV (1927) p. 344, ubi syn.

Exsic. (sec. Vain. l. c.). Arnold Lich. Exsic. No. 635 a, b et 1397. Fellm. Lich. Arct. No. 196. Flot. Lich. Exsic. No. 172, A et B (p. p.). Fries Lich. Suec. XIII No. 382 B p. p. Hepp Flecht. Eur. I (1853) No. 36. Krypt. Vind. (1898) No. 263 a, b. Lojka Lich. Hung. IV (1884) No. 173. Malme Lich. Suec. I (1897) No. 15 et VII (1910) No. 173. Schaer. Lich. Helv. VIII (1828) No. 178 p. p. Zwack Lich. Exsic. No. 607.

West Greenland. Maligiaq (Th. Fr.).

East Greenland. Davysund: Traill Island: Holmsvika (Lyngé).

It is a very rare species in the Arctic. In addition to these two Greenland localities I have only seen one Arctic plant: Novaya Zemlya: Matotchkin Schar (Lyngé l. c.). It has also been recorded from Novaya

Zemlya by Deichmann Branth (Lich. fra Nov. Semlia (1887) p. 77. I have not seen this plant. It has never been found in Svalbard, and it has not been mentioned in the Records on the lichens of the Vega Expedition from the East Siberian coasts. It has not been identified in Simmon's collections from Ellesmereland. — Vainio records it from Kola: Kildin (l. c.).

Deichmann Branth et Rostrup record two finds from Greenland: Fredrikshaab and Upernivik (Grönl. Lich. Flora (1887) p. 507). But I found no *Rhiz. distinctum* in the Copenhagen Greenland herbarium.

There is only one small plant in my Greenland collection. It was half overgrown by other lichens, such as *Rhiz. geographicum* and others. The same is the case with Th. Fries's Greenland plants, and with my Novaya Zemlya plant. Malme has made the same observation. It is always inferior in competition.

My Greenland plant has a distinct black hypothallus, carrying very small dispersed grey areolae. The apothecia are small, 0.5 mm, plane, with a thin persistent margin. The hymenium is high, about 100 μ , almost black in its upper part, with a faint tinge of violet, more distinctly so, if KOH is added. The spores are uncoloured, with 3 transversal septa and 1, rarely 2, of the central cells crossed by 1 longitudinal septum. Spore size $25-32 \times 12-13 \mu$.

Medulla blue with J, uncoloured with KOH.

6. *Rhizocarpon obscuratum* (Ach.) Mass.

Th. M. Fries Lich. Scand. II (1874) p. 628, p. p. Malme Rhizocarpon (1914) p. 279 et 293. Vainio Lich. Fenn. II (1922) p. 278 et 297, p. p. Lynge Lich. Bear Isl. (1926) p. 37; Lich. Nov. Zemlya (1928) p. 148. Zahlbruckner Cat. Lich. IV (1927) p. 376.

Exsic. (sec. Vainio l. c.). Anzi Lich. It. sup. VII (1865) No. 307, 309. Arnold Lich. Exs. (1879) No. 815 a b, (1880) No. 853, (1888) No. 1396. Lich. Monac. (1890) No. 119. Flot. Lich. Exsic. (1829) No. 174. Havås Lich. Norv. (1902) No. 118. Malme Lich. Suec. I (1897) No. 16. Schaer. Lich. Helv. VIII (1828) No. 177 p. p. Zwack Lich. Exsic. (1852) No. 133, (1879) No. 546 A B, 547, 548, (1880) No. 607.

West Greenland. Disko: Blæsedalen (Th. Fr.).

East Greenland. Cape Humboldt (Lynge).

It is one of the rarest *Rhizocarpons* in Greenland. Recorded from Upernivik by Deichmann Branth et Grönlund (Grönl. Lich. Flora, 1888, p. 507). The record is not at all improbable, but there was no such plant in the Copenhagen herb.

Rhizocarpon obscuratum has a limited distribution between West Greenland and Novaya Zemlya. No plants have so far been identified in the Ellesmereland collection of Simmons (Sec. Arct. Norw. Exped. in

the Fram). It is better represented in our Svalbard collections (from Spitsbergen proper, Bear Island and Hope Island). I collected only a few plants in Novaya Zemlya.

In my only Greenland plant the thallus is hardly visible under a lens of moderate power. But I found spores that were uncoloured, muriform and pauciloculated, often tetrablastous, or with one oblique longitudinal septum. The spores are rather large: $31-35 \times 14-16 \mu$.

Sect. II. *Catocarpus* Th. Fr.

7. *Rhizocarpon chionophilum* Th. Fr.

Th. Fries Lich. Scand. II (1874) p. 612, Lich. English Polar Expedition of 1875—76 (1879) p. 365. Malme *Rhizocarpon* (1914) p. 276 et 280. Vainio Lich. Fenn. II (1922) p. 279 et 320. Lynge Lich. Nov. Zeml. (1928) p. 131 et pl. III, fig. 21—22 et pl. VIII, fig. 4; Lich. Taimir Penins. (1929) p. 11. *Buellia alpicola* (Wbg. p. p.) Th. Fries Lich. Spitsb. (1867) p. 45. *Rhizocarpon alpicola* (Schaer.), Deichmann Branth et Rostrup Grönl. Lich. Flora (1887) p. 507. Zahlbr. Cat. Lich. IV (1927) p. 319.

Exsic. Krypt. Vind. No. 2772. Malme Lich. Suec. XIV (1913) No. 347. — Claud. et Harm. Lich. Gall. exsic. No. 345 is *Rhizocarpon alpicola* (Schaer.) Flag.: sporae dyblastae, deinde obscuratae, $28 \times 14-15 \mu$, medulla J ÷, KOH non rubescens. — I have not access to Zahlbr. Lich. rar. exsic. No. 25.

West Greenland. Disko Bay: Kronprinsen Island (Kruuse). Holsteinsborg: Nepissat (Th. Fr.). Godthaab (Th. Fr.). Julianehaab (Vahl): Igaliko: Narssârssuk (?), written Narksursuk on the label, Vahl) and Nanortalik (Eberlin).

East Greenland. Umânaq (Eberlin). Scoresbysund, pluribi: Danmarks Ø, Hekla Havn and Kobberpynten (Hartz).

It is widely distributed in the Arctic, but not so common as many other lichens. In addition to the Greenland localities there are numerous finds in our herb. from Spitsbergen proper (not from Bear Island), and also from Novaya Zemlya (leg. Lynge) and 1 from Ellesmereland (leg. Simmons).

In South Greenland it is found along the (whole?) coast between Disko and Scoresbysund, like so many other lichens.

In Norway *Rhizocarpon chionophilum* ascends to the highest summits. It is very characteristic of our high-alpine rock-falls. I was therefore astonished at not finding it in North East Greenland in 1929, though I was eagerly hunting for it.

In old collections, and in literature, it is often found under the head of *Rhizocarpum geographicum* or *Rhiz. alpicola*. The latter species has so far not been found in Greenland; cfr. *Rhiz. geographicum* in the present paper.

8. *Rhizocarpum crystalligenum* Lynge n. sp.

Thallus 2—6 cm latus, crustaceus, uniformis, epruinosis et esorediatus. *Thallus ochroleucus vel citrinus*, areolatus. Areolae diam. 3—6 mm, dispersae vel plus minusve contiguae, lineis nigris hypothallinis separatae, planae vel leviter convexae, in margine varie crenatae, superne lineis reticulatis impressis rugulosae vel etiam diffractae. — Hypothallus ater, subnitidus, reticulato-rimosus, areolae minutae, diam. 0.1—0.2 mm, subconvexae.

Apothecia numerosa, inter areolis sita, thallum parum superantia, mediocria, diam. usque ad 1 mm. Discus ater, epruinosis, leviter convexus, margine evanescenti circumdatus. Excipulum violaceo-fuscescens, etiam cum hypothecio. Hymenium angustum: 80—95 μ altum, in parte superiori fuligineum vel violaceo-fuligineum, praeterea incolor vel dilutissime roseum. Paraphyses arcte conglutinatae, in apice haud vel leviter solum incrassatae. *Sporae* octonae vel vulgo abortu pauciores, *obscurae, uni-septatae*, medio leviter constrictae, *parvae*: 13—16 (—18) \times 7.5—8.5 μ , halone tenui circumdatae.

Medulla J \div , KOH rubescens (crystalla praecipitantur, ut in *Rhiz. chionophilo*).

East Greenland. Scoresbysund: Danmarks Ö (Hartz). Frans Josef Fjord: Cape Humboldt (typus) and Muskox Fjord (Lynge). — It is rare and scarce; there were only three plants in my collection.

Rhiz. crystalligenum has a very conspicuous hypothallus. In some plants the areolae are resting on it as quite discrete areolae, in other plants they are more confluent, but separated by very distinct hypothalline lines. In the type plant the areolae form fan-like (flabelliform) structures towards the margin of the thallus.

The habitus is very like *Rhiz. chionophilum*, and when I found my plants I was not in doubt that I had found that species. But it differs by its much smaller spores; in *Rhiz. chionophilum* the spores are 18—28 \times 9—15 μ large, and also by its more violet hymenium. *Rhiz. superficiale* = *Rhiz. effiguratum* has spores of the small size: 11—15 \times 7—10 μ , sec. Th. Fries Lich. Scand. p. 613, but it differs by its positive J-reaction.

The spore size suggests a *Buellia*, but I saw a distinct hyaline halo around the spores, and the habitus of the plant is entirely that of a *Rhizocarpum*.

Our large Arctic material of *Rhiz. chionophilum* from Svalbard and Novaya Zemlya was carefully reexamined. But not a single plant had spores of this size. *Rhiz. crystalligenum*, as well as *Rhiz. occidentale*, are supposed to be plants of western distribution.

In the Copenhagen herb. Hartz's plant was referred to *Rhiz. effiguratum*. It has the small spores of that species, but it differs in its chemical reaction with J, as well as with KOH (*Rhiz. effiguratum* is J+ and KOH ÷). Its habitus is entirely that of *Rhiz. chionophilum*.

9. *Rhizocarpon occidentale* Lynge n. sp.

Differt a *Rhiz. crystalligeno* reactione chemica: medulla KOH immutata vel flavescens, sed non rubescens. Hymenium superne violaceum. Sporae dyblastae, obscurae, parvae: 13—18×7—9 μ . Praeterea ut in specie commemorata.

East Greenland. Davysund: Cape Simpson and Holmsvika (Lynge). Vegasund: Husbukta (Lynge). Frans Josef Fjord: Myggbukta, Cape Humboldt, Reinbukta and Kierulf Fjord (Lynge). Near Cape Wynn: Landingsdalen (Lynge).

This species is widely distributed in North East Greenland, and not rare, but I never found it plentiful.

Rhizocarpon occidentale and *Rhiz. crystalligenum* are a new set of closely related *Rhizocarpons*, differing inter alia in their chemical reactions: *Rhiz. Copelandii* — *Rhiz. jemtlandicum*; *Rhiz. chionophilum* — *Rhiz. alpicola*; *Rhiz. chionophiloides* — *Rhiz. chionophilum*. Our knowledge of the physiology of the lichens is so deficient. A physiological research might perhaps give the cause of this difference, and tell us whether the difference is always of specific importance. In the case of *Rhiz. grande* — *Rhiz. endamyleum* the difference is not acknowledged to be of specific importance.

Rhizocarpon occidentale differs from *Rhiz. superficiale* in the medullary reaction with J, which is J ÷ in the former species, J+ in the latter species.

Rhizocarpon occidentale is nearly related to *Rhiz. simulans* Magn. (New Species of Lichens in the North of U. S. S. R. (1927), and perhaps identical. I sent a good specimen to Magnusson for comparison. Magnusson writes that his species differs in its paler excipulum, capitata paraphyses which are not violet, and a thicker cortex. He is not inclined to regard them as specifically identical.

10. *Rhizocarpon superficiale* (Schaer.) Malme.

Malme *Rhizocarpon* (1914) p. 282; Malme Lavar, Svenska Exp. till Jan Mayen och nordöstra Grönland (1929) p. 5. Vainio Lich. Fenn. II (1922) p. 279 et 319. Zahlbruckner Cat. Lich. IV (1927) p. 342.

Lecidea effigurata (Anzi) Stiz. Vain. Lich. Pitlek. (1909) p. 114. *Rhizocarpon effiguratum* (Anzi) Th. Fr. Lich. Scand. II (1874) p. 281. Malme *Rhizocarpon* (1914) p. 276 et 281.

Exsic. Arn. Lich. Exs. (1892) No. 1556. Havås Lich. Norv. Exs. (1907) No. 366, Lich. Norv. Occid. Exs. II (1913) No. 48.

East Greenland. Drottning Augusta's Dal, near Flache Bay (Malme 1929, l. c.).

This is a very interesting find. I only know one previous Arctic record, Vainio's from Pitlekai. It is difficult to explain a distribution like this, if it should not be found along the Arctic American coast, the terra incognita in Arctic lichenology.

It was only to be expected that some lichens should have a distribution of that kind. We have e. g. *Evernia mesomorpha*. It was found by the Vega Expedition at Konyam Bay and at Port-Clarence (Nyl. Enum. Lich. Freti Behr., 1888, p. 214 and 257), and in East Greenland at Myggbukta by Scholander (Lyngé et Scholander Lich. North East Greenland, 1931, p. 84). There is an unpublished find from Bernard Harbour, (Lat. 68° 47', Long. 114° 46' W., leg. Frits Johansen, Canad. Arctic Exp.). — Farther south it has a wider distribution, through the whole northern temperate zone.

11. *Rhizocarpon Copelandii* (Kbr.) Th. Fr.

Th. M. Fries Lich. Scand. II (1874) p. 615. Malme *Rhizocarpon* (1914) p. 277 et 284. Mathiesen Lichens Jan Mayen (1924) p. 25. Lyngé Lich. Spitsb. (1924) p. 18, Lich. Bear Isl. (1926) p. 35, Lich. Nov. Zeml. (1928) p. 135 et pl. III, fig. 27—29, VIII, fig. 2, Lich. Taimir Peninsula (1929) p. 11, Lich. South East Greenl. (1932) p. 14. Zahlbr. Cat. Lich. IV (1927) p. 331, ubi syn. *Buellia Copelandii* Koerber Flecht. Zw. deutsche Polar-Exped. (1874) p. 79, Lich. Spitzb. u. Nov.-Semljas (1875) p. 5. Deichm. Branth et Rostr. Grönl. Lich. Flora (1887) p. 505. *Rhizocarpon hyperboreum* Vain. Lich. Fenn. II (1922) p. 331. Non *Rhizocarpon Copelandii* (Kbr.) Vain. l. c. p. 329.

Exsic. Malme Lich. Suec. XI (1912) No. 275 et XVII (1914) No. 422.

West Greenland. Disko: Itiodlek (Porsild) and Marraq (Rosenvinge). Godthaab (Th. Fr.). Fredrikshaab: Arsuk (det. Th. Fr., sec. D. B. l. c.), Julianehaab: Nanortalik (Eberlin).

East Greenland. Umânaq (Eberlin), Umanak: Vogtsbu (Björlykke). Shannon Isl. (sec. Kbr., locus classicus).

This species is widely distributed in the Arctic, known from Greenland, Jan Mayen, Svalbard, Novaya Zemlya, and the Taimir Peninsula. In Greenland it is widely distributed, but perhaps not of the commonest species, between Disko Isl. in the west and Shannon Island in the east; the finds suggest a continuous distribution.

It was overlooked by me during Norwegian expedition to North East Greenland.

All the plants seen have been microscopically examined. It is easily determined on account of its 1-septated, medium-sized spores: Malme writes $20-25 \times 10-12 \mu$, Lyngé in Novaya Zemlya $20-27 \times 10-13 \mu$; the Greenland plants have spores of the same size, rarely surpassing 25μ . Its hymenium is "aeruginose" at the upper part, its apothecia are convex, and red needles are precipitated by KOH.

In old herbaria it is often found under the species names of "*atroalbum*" or "*badioatrum*".

Nylander records a "*Lecidea Copelandi* Kbr." from Lawrence Bay (Enum. Lich. Freti. Behr. (1888) p. 210, and from Behring Island (l. c. p. 253), but it is "*Medulla K flavens*", an *Rhiz. jemtlandicum*?

12. *Rhizocarpon badioatrum* (Flk.) Th. Fr.

Th. M. Fries Lich. Scand. II (1874) p. 613. Malme *Rhizocarpon* (1914) p. 277 et 282. Vain. Lich. Fenn. II (1922) p. 279 et 325, ubi syn. Lyngé Lich. Spitsb. I (1924) p. 18, Lich. Bear Isl. (1926) p. 34, Lich. Nov. Zeml. (1928) p. 133, Lich. South East Greenl. (1932) p. 14. Zahlbr. Cat. Lich. IV (1927) p. 322, ubi syn. — Haud *Buellia atroalba* (Ach.) Deichm. Branth et Rostr. Grönl. Lich. Flora (1887) p. 505. This species, including *Rhizocarpon* (or *Buellia*) *badioatrum* in herb. Copenh. is for the greater part *Rhizocarpon jemtlandicum* or *Rh. Copelandii*, which see. — Non *Catocarpon badioatrum* (Flk.) Th. Fr. in Darbshire Lich. Fram Exp. (1909) p. 22; the plant is *Rhizocarpon jemtlandicum* (herb. Oslo).

West Greenland. Godthaab (Th. Fr.), Ujarasurksoit ("Ujaragssuit?", J. Vahl), "Grönland 1884" (Fylla Exp.).

East Greenland. Akorninarmiut: Eidsdalen (Björlykke).

Rhizocarpon badioatrum is not common in the Arctic, it is generally substituted by other species, such as *Rh. jemtlandicum* and *Rh. Copelandii*. It cannot be common in Greenland, where it is supposed to be restricted to the southern part of the country. It was not found by the Norwegian expeditions to North East Greenland.

The plants are typical, with a brownish thallus, a violet hymenium, and 1-septated large spores, up to 35 or 40μ in the largest ones.

13. *Rhizocarpon Rittokense* (Hellb.) Th. Fr.

Th. M. Fries Lich. Scand. II (1874) p. 615, Lich. Engl. Polar Exp. (1879) p. 365. Malme *Rhizocarpon* (1914) p. 277 et 284. Vainio Lich. Fenn. II (1922) p. 279 et 324. Zahlbr. Cat. Lich. IV (1928) p. 133. Lyngé Lich. Nov. Zeml. (1928) p. 133. Non *Catocarpon Rittokense*

(Hellb.) Th. Fr. in Darb. Lich. Fram Exped. (1909) p. 22 (= *Rhiz. jemtlandicum*).

Exsic. Norrl. et Nyl. Herb. Lich. Fenn. VII (1882) No. 345.

West Greenland. Cape York (sec. Th. Fr. 1879 l. c.). Disko Bay: Kronprinsen Island (Kruuse). Godthaab, several plants (Th. Fr.). Kobbefjorden (Warming 1884). Julianehaab: Nanortalik (leg. ?).

Rhizocarpon Rittokense is a rare species of limited distribution in the Arctic. It is found along the whole west coast of Greenland; in addition to that there is only one find from Novaya Zemlya. It has never been found in the Svalbard region. Its known distribution suggests a western distribution.

It is easily identified, but it should not be determined after its habitus, in order to avoid confusion with *Lecidea paupercula* or *Lecidea fumosa*.

14. *Rhizocarpon groenlandicum* Lynge n. sp.

Hypothallus optime evolutus, ater, subnitidus, fissuris reticulatis in areolis rugosis divisus, versus marginem plus minusve distincte radiatus, crassus. Supra hanc hypothallum areolae discretae vel deinde versus centrum magis confluentes evolutae sunt. *Areolae* juveniles hypothallo fere concolores, deinde magis in *fusciscentem coloratae*, vel etiam leviter in cinerascens, ab initio *valde nitidae et depresse verrucosae*, deinde magis irregulares, rugosae. *Areolae juveniles secundum marginem pallidius coloratae*.

Apothecia inter areolis sita, mediocria, diam. usque 0.8 vel etiam 1.0 mm. Discus primum planus, margine tenui cinctus, deinde convexus. Hypothecium fusco-nigricans. Hymenium altum: 130—135 μ , superne caeruleo-nigricans, paraphyses conglutinatae, praecipue in apice. Sporae ab initio octonae, sed deinde vulgo abortu pauciores, saepe corrugatae, *obscurae*, *dyblastae*, in apice rotundatae, in medio leviter contractae, 17—21 \times 10—11 μ , halone distincto circumdatae.

Hymenium J persistenter caeruleo-nigrescens, KOH pulchre smaragdulum. *Medulla* J \div , KOH \div , CaCl_2O_2 *rubescens*.

East Greenland. Frans Josef Fjord: Cape Humboldt (Lynge).

The new species habitually resembles *Rhiz. Rittokense*, but it differs from that species in its chemical reaction (*Rhiz. Rittokense* is J +, CaCl_2O_2 \div), its convex apothecia with a bluish hymenium, and its convex areolae. Its thick, cracked hypothallus is also different from the thin, smooth hypothallus of the said species. The latter character is, however, less important, for in the Arctic many crustaceous lichens develop a fine hypothallus at the cost of the areolae.

The convex apothecia call to mind *Rhiz. Copelandi* (Kbr.) Th. Fr., which was first collected in Shannon Island, North East Greenland.

Though our field of investigation largely covered that of the Second German Polar Expedition, I did not find *Rhiz. Copelandii*, to my great disappointment. But *Rhiz. groenlandicum* is sufficiently distinct from that species by its chemical reaction ($\text{KOH} \div$), and by its areolae, which are nitidous with a distinct pale edge.

It differs from *Rhiz. jemtlandicum* by its positive reaction with CaCl_2O_2 , and by its areolae.

15. *Rhizocarpon jemtlandicum* Malme.

Malme *Rhizocarpon* (1914) p. 277 et 283. Lynge Lich. North Coast Greenl. (1923) p. 287, Lich. Spitsb. I (1924) p. 19, Lich. Nov. Zemlya (1928) p. 133, Lich. Taimir Peninsula (1929) p. 12, Lich. Franz Josef Land (1931) p. 13. Zahlbr. Cat. Lich. IV (1927) p. 333. *Buellia atroalba* (Ach.) Flot. p. m. p. in Th. Fries Lich. Arct. (1860) p. 230, Lich. Spitsb. (1867) p. 44 (p. m. p. = *Rhiz. Copelandii*). *Rhizocarpon Copelandi* (Kbr.) Th. Fr. Vainio Lich. Fenn. II (1922) p. 329, sed non *Buellia Copelandi* Kbr. Flechten, Zw. Deutsche Polar Exp. (1874) p. 79, vide Lynge Lich. Bear Isl. (1926) p. 35. *Catocarpon badioatrum* (Flk.) Th. Fr. et *Catocarpon Rittokense* (Hellb.) Th. Fr., in Darb. Lich. Fram Exped. (1909) p. 22.

Exsic. Magnusson Lich. sel. Scand. II (1929) No. 45. Malme Lich. Scand. XIV (1913) No. 349.

North Greenland: J. P. Koch Fjord (Wulff).

West Greenland: Disko Fjord: Nepisat (Th. Fr.) Godthaab (Th. Fr.). Julianehaab: Nanortalik (Vahl).

East Greenland. Scoresbysund: Danmarks Ö (Hartz) and Hekla Havn (Hartz).

Rhizocarpon jemtlandicum is widely distributed in the Arctic, but hardly common. Its known distribution is from Ellesmereland in the west (Simmons), over Greenland, Spitsbergen, Franz Josef Land and Novaya Zemlya to Taimir Peninsula in the east. I have not seen Nylander's "*Lecidea atroalba* Flot." from Bering Island (Enum. Lich. Freti Behr. (1888) p. 254). If this name covers *Rhiz. jemtlandicum*, as it often does in Arctic literature, the species must be regarded as circumpolar.

It is most probably found all over the coasts of Greenland, but it is hardly common. It is one of several plants, which we should have expected from the fjord region north of Scoresby Sund, but which I searched for in vain.

A very aberrant plant was collected at "Klubben 4000'", in Scoresbysund, by Hartz. Deichmann Branth referred it to *Rhiz. Rittokense*, but it differs by its habitus and by the aeruginose colour of its hymenium.

Its areolae are subdiscrete, pale brownish, concolourous, i. e. not paler at their margin, somewhat verrucose, and nitidous.

I have referred the plant to *Rhiz. jemtlandicum*; it is perhaps a shadow forma, or perhaps its f. *pallidofuscescens* Vain., which I have not seen.

16. *Rhizocarpon polycarpum* (Hepp) Th. Fr.

Th. M. Fries Lich. Scand. II (1874) p. 617. Malme *Rhizocarpon* (1914) p. 277 et 285. Vainio Lich. Fenn. II (1922) p. 280 et 338. Lynge Lich. Spitsb. I (1924) p. 19; Lich. Nov. Zemlya (1928) p. 137 et pl. III, fig. 15—16; Lich. Taimir Penins. (1929) p. 12. Zahlbr. Cat. Lich. IV (1927) p. 338. *Lecidea atroalbicans* Nyl. Enum. Lich. Freti Behr. (1888) p. 232. Vainio Lich. Pitlek. (1909) p. 115. *Buellia atroalba* (Ach.) Th. Fr. Deichmann Branth et Grönl. Grönlands Lich. Flora (1887) p. 505 p. p.

Exsic. Arnold Lich. Exsic. (1870) No. 437, (1873) No. 559 a—c, (1880) No. 852. Havås Lich. Norv. Exsic. (1904) No. 201. Hepp Flecht. Eur. I (1853) No. 35. Krypt. Vind. III (1898) No. 265.

West Greenland. Disko, many places: Mellemfjorden and Nepisat (Th. Fr.), and Ekalunguit Itivnerit (Porsild). Sukkertoppen (Warming).

East Greenland. Nuk (61° 28' n., leg. Eberlin).

Rhizocarpon polycarpum is a circumpolar lichen. We have so many plants from Spitsbergen and from Novaya Zemlya that it must be quite common there. Its frequency in the Bering Strait region is not clearly seen from literature. It is not supposed to be common in Greenland, so far we have only one find from East Greenland, and none from North Greenland.

17. *Rhizocarpon Hochstetteri* (Kbr.) Vain.

Lich. Fenn. II (1922) p. 280 et 332, ubi syn. Lynge Lich. Bear Isl. (1926) p. 36. *Rhizocarpon applanatum* (Fr.) Th. Fr. Lich. Scand. II (1874) p. 618. *Lecidea colludens* Nyl. Enum. Lich. Freti Behr. (1888) p. 210. *Lecidea Hochstetteri* (Kbr.) Vain. Lich. Pitlek. (1909) p. 115. *Rhizocarpon Massalongii* (Kbr.) Malme *Rhizocarpon* (1914) p. 278 et 285. Lynge Lich. Nov. Zemlya (1928) p. 136, Lich. Taimir Peninsula (1929) p. 12. Zahlbruckner Cat. Lich. IV (1927) p. 334.

Exsic. (formae variae, sec. Malme et Vain. l. c.) Arnold Lich. Exsic. (1879) No. 813. Fries Lich. Exsic. XIII (1827) No. 382 C. Havås Lich. Norv. (1904) No. 202. Malme Lich. Suec. V (1909) No. 124, XI (1912) No. 274. Norrl. et Nyl. Herb. Lich. Fenn., cont. (1921) No. 728. Schaer. Lich. Helv. VIII (1828) No. 180 B. Zwack Lich. Exsic. No. 202.

West Greenland. Upernivik (Kold. Ros.): Qeqertarssuaq (? written Kekertatsiak on the herb. label, leg. Eberlin). Disko: Mellemfjorden,

Kuanerssuit and Nepisat (Th. Fr.). Godthaab (Th. Fr.). Fredrikshaab: Smallesund (Kold. Ros.). Julianehaab: Nanortalik (Eberl.).

East Greenland. Scoresbysund: Hekla Havn and Danmarks Havn (Hartz).

It is widely distributed in the Arctic, but it is nowhere plentiful. There are many plants from Spitsbergen and Bear Island (Th. Fries, Lynge and Höeg) in our herb., and also some plants from Novaya Zemlya and from the Taimir Peninsula. The Vega Expedition collected it on the East Siberian coast. We have no records from the Canadian Arctic coast, as far as I know. It has not (yet) been identified in Simon's collections from Ellesmereland. Yet there is good reason to suppose that it is a circumpolar species.

In Greenland it is evidently scarce, but it has a continuous distribution along the west coast as far north as Upernivik. From the east coast we only have Hartz's finds from Scoresby Sund.

In the Copenhagen herb. it has (p. p.) been called *Rhiz. expallens* (Danmarks Ø), or *Rhiz. badioatrum* (Hekla Havn), but it is sufficiently distinct from these species by the structure of its apothecia and spores: Upper part of hymenium olive-black, paraphyses slightly capitate (KOH), spores one-septated, uncoloured, $24-26 (-30) \times 13-17 \mu$. A correctly determined plant from Hekla Havn had so large spores as 30μ .

Its synonymy is very intricate. According to Vainio Lich. Pittek. l. c. Nylander's *Lecidea colludens* from 1870 is a synonym of this species.—Malme has shown that Th. Fries's species name *applanatum* is not valid. (Rhizocarpon (1914) l. c.). He gives preference to the species name *Massalongii* Kbr. Parerga (1865) p. 195. — But A. Schade, Dresden, has examined the type plant of Koerber's "*Catillaria Massalongii*" in herb. Leiden. He has been kind enough to tell me (in litt.) that Koerber's plant is a *Biatora*, with simple, small spores, about $7.5 \times 5 \mu$. It is accordingly not easily understood why that species name has been applied to this species. — After that, Koerber's other name *Hochstetteri* must be the valid species name, as far as I can see.

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geminatum (Flot.) Kbr. 15.
geographicum (L.) DC. 4,
6, 9, 11, 12, 13, 16,
17, 19.
grande (Flk.) Arn. 6, 10,
13, 20.
— f. atrocaesium (Nyl.)
17, 14.
— f. parasitica Lynge 14.
— var. quaternaria Th.
Fr. 15.
groenlandicum Lynge 6,
11, 23, 24.
Hochstetteri (Kbr.) Vain.
6, 11, 25, 26.
hyperboreum Vain. 21.
infernum (Nyl.) 7.
inops Kbr. 15.
jemtlandicum Malme 6,
11, 20, 22, 23, 24, 25.
— f. pallidofuscescens
Vain. 25.
lavatum (Fr.) Arn. 6.
leucopsephum (Nyl.) A.
Zahlbr. 7.
Massalongii (Kbr.) Malme
25, 26.
melaneimum (Vain.) A.
Zahlbr. 7.
Montagnei 16.

Rhizocarpum

obscuratum (Ach.) Mass.
6, 10, 17.
occidentale Lynge 6, 10, 20.
ochrodelum (Nyl.) A.
Zahlbr. 7.
Oederi 5.
oreites (Vain.) Zopf. 12.
petraeum (Wulf.) 6, 13.
phalerosporum Vain. 6.
polycarpum (Hepp) Th. Fr.
6, 11, 25.

Rhizocarpum

postumum (Nyl.) Th. Fr.
7, 9.
praebadium (Nyl.) A.
Zahlbr. 7.
pseudospeireum (Th. Fr.)
Lynge 6, 8.
Rittokense (Hellb.) Th.
Fr. 5, 6, 10, 22, 24.
roridulum Th. Fr. 6.
semotulum (Nyl.) A.
Zahlbr. 7.

Rhizocarpum

simulans Magn. 20.
subalpicolum (Nyl.) A.
Zahlbr. 5, 7.
superficiale (Schaer.)
Malme 5, 7, 9, 10, 12,
19, 20.
verrucosum Lynge 6.
viridiatrum (Flk.) Kbr. 6,
9, 12.
Rinodina
Hueana 14.

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